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STATION PAPER NO. 26 DECEMBER 1951

QUALITY OF LOGS AND LUMBER OBTAINED FROM AN IMPROVEMENT CUT IN SECOND-GROWTH HARDWOODS IN NORTHERN WISCONSIN

CARL ARBOGAST, JR.

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U. S. Department of Agriculture, Forest Service
Lake States Forest Experiment Station 1/

Station Paper No. 26 December 1951

QUALITY OF LOGS AND LUMBER OBTAINED FROM AN IMPROVEMENT CUT IN SECOND-GROWTH HARDWOODS IN NORTHERN WISCONSIN 2/

By Carl Arbogast, Jr. 3/

THE PROBLEM

More than three-quarters of the two million acres of northern hardwoods in northern Wisconsin are second-growth. Typical stands are composed of three distinct age groups: residuals of the original merchantable-sized stands that were cull trees at the time of logging; trees that were too small to be merchantable at the time of logging; and finally, trees that were small seedlings at that time or have seeded in since logging.

Silviculturally, these stands are in an undesirable condition. The oldest age class in the stand is composed of inferior or cull trees more than 150 years old which are making no net growth and are suppressing and deforming the remainder of the stand. Occasionally a merchantable log may be cut from the upper part of the stem, but the net scale of a typical tree is seldom more than 20 percent of the gross scale.

The middle age group consists of trees from 12 to 18 inches in d.b.h. and 60 to 70 feet tall. Thirty to forty years after logging, this group contains almost all the merchantable volume in the stand. Some of these trees are of good vigor and form and can be expected to provide high-quality logs in the future. But many of the trees in this group are defective because of old logging injuries, sunscald caused by the severe exposure after the original cut, or because of animal and insect damage or decay. 4/

The third and youngest group, made up of trees from 5 to 13 inches in d.b.h. and 40 to 60 feet tall, is the potential source of high-grade timber in the future. The trees in both the first two groups are suppressing and deforming those in this class.

1/ Maintained at University Farm, St. Paul, Minnesota, by the U. S. Department of Agriculture in cooperation with the University of Minnesota.

2/ Credit is due C. B. Hanson and Sons for the use of their sawmill and assistance in grading of lumber, and to J. H. Stoeckeler, M. L. Heinselman, H. C. Bell, H. R. Burmeister, E. R. Stoltz, and Lucille P. Olsen of the Forest Service for assistance in planning the study, or collecting, summarizing, and analyzing the data.

3/ Research Forester, U. S. Forest Service, Northern Lakes Branch, Lake States Forest Experiment Station, Rhinelander, Wisconsin.

4/ Porcupine damage in a northern hardwood-hemlock forest of northeastern Wisconsin. Lake States Forest Experiment Station Technical Note No. 326, 1 page, January 1950.

A POSSIBLE SOLUTION

As soon as they are economically feasible, improvement cuts should be started in these stands. The immediate silvicultural aim of these cuts should be to better stand quality by:

1. Removal of cull trees as rapidly as possible without creating excessively large openings which might lead to undesirable epicormic sprouting of residual trees.

2. Reduction of poor growing stock in favor of well-formed, thrifty trees in the understory and codominant stand.

If a market for hardwood pulpwood develops in the future, the major economic obstacle to this type of cut will be largely removed. Chemical wood and fuel-wood markets would also be able to utilize the material from these cuttings, but such markets are extremely limited in this area now. At present the sawlog market is the only commercial outlet for low-quality trees. This market in the locality of the study is primarily concerned with the manufacture of standard lumber from the hardwood logs and not with products to which low-grade logs are better adapted, such as crating, blocking, railroad ties, etc. To manufacture special low-grade products profitably, the mill arrangement and machinery would have to be modified drastically from that used to produce factory lumber, and most owners have not seen fit to make such changes.

TESTING THE PROPOSED SOLUTION

To determine the quality of logs and lumber removed in an improvement cutting of a typical second-growth northern hardwood stand in northeastern Wisconsin, a mill-scale study was made on the yield from 60 acres on the Argonne Experimental Forest in the summer of 1949. The specific aims of this study were to learn:

1. Lumber grade yield, and lumber values.

2. Overrun of lumber tally above the log scale for a circular mill using the Scribner Decimal C log rule.

3. Whether the Forest Products Laboratory log grade rules for mill run hardwood logs (primarily old-growth) could successfully predict the lumber values obtained from an improvement cut in second-growth hardwoods.

4. The economic feasibility of making improvement cuts in second-growth hardwood stands of the type described.

How the Study Was Made

Three 20-acre blocks of second-growth hardwoods were selected on the Argonne Experimental Forest and marked for an improvement cut. The area was then logged. All the logs produced on each block were kept separate at the mill until the mill scale study started. During the course of the study, no logs other than those from the study area were sawn.

A circular mill with a capacity of 15 M board feet per 8-hour day, in Forest County, Wisconsin, was chosen for the study. It was selected as being representative of the type of mill which could be expected to utilize the kind of logs produced.

The logs were scaled, graded, (using the grade rules developed by the Forest Products Laboratory),5/ and numbered on the log deck. The log number was transferred to each board as it was cut. These boards were graded and tallied on the green chain by log number. This tally was later reassembled by logs for analysis.

The Findings

Altogether, 1,120 hardwood logs were followed through the mill, of which 991 (88.5 percent) met the merchantability standards6/ for hardwood sawlogs (table 1). Eighty-one (7.2 percent) of the logs were below the minimum top diameter, and are referred to hereafter as "submerchantable" logs. Forty-eight (4.3 percent) of the logs had a net scale of less than 33-1/3 percent of the gross scale, so they are called "cull" logs. The net scale (Scribner Decimal C) of all logs was 36,720 board feet, as compared to 49,078 board feet green lumber tally (table 1). Most of the volume was in merchantable logs. The average top diameter inside the bark of the hardwood logs was 10.3 inches for the total cut; the merchantable logs averaged 10.6 inches d.i.b.; the submerchantable 6.8 inches d.i.b.; and the cull logs 11.6 inches. A total of 752 softwood logs were cut, of which none were culls and only 9 were submerchantable.

The value, net scale, cull percent, and overrun varied considerably by species. Sugar maple and yellow birch, which comprised 85 percent of the hardwood logs cut, were relatively high both in cull percent and overrun. Basswood was much lower in both categories. White ash, represented by 5 logs, was the only species that gave a lower lumber tally than log scale for merchantable logs (table 1).

The comparison of the value per M board feet lumber tally and log scale of the lumber cut from the merchantable, submerchantable, and cull hardwood logs brings to attention the tendency of overrun to compensate for the low quality of lumber obtained from small logs (table 1). The Scribner Decimal C log rule does not give enough overrun to completely counter-balance the low value of small logs, but it does eliminate a large amount of the difference. These small logs are more expensive to log and mill per unit of volume. Even with the high overrun it is doubtful that they can be handled profitably for factory lumber.

5/ Hardwood log grades for standard lumber. Proposals and results. March 1949. No. D1737. Forest Products Laboratory, Madison, Wisconsin.

6/ A hardwood log must be at least 8 feet long, at least 8 inches in average diameter inside the bark at the small end, and must have a net scale of at least 33-1/3 percent of the gross scale of the log to be considered merchantable. Softwood logs are taken to a 6-inch top diameter inside the bark.

Table 1.--Amount and value of lumber produced from logs of different species and classes

Species and log class	Logs		Net log scale Scribner Decimal C		Green lumber tally		Cull	Overrun dry lumber[1]	Value per M bd.ft.	
									Log scale	Lumber tally
	Number	Percent	Bd.ft.	Percent	Bd.ft.	Percent	Percent	Percent	Dollars	
Sugar maple										
Merchantable	576	91.0	21,420	97.8	28,266	95.0	19.1	25.4	88.47	70.55
Submerchantable	33	5.2	475	2.2	851	2.9	3.0	70.2	79.99	47.00
Cull	24	3.8	-	-	633	2.1	[2/][3/]80.0	-	[4/]-	65.12
Total	633	100.0	21,895	100.0	29,750	100.0	[3/]23.6	29.1	[4/]90.07	69.77
Yellow birch										
Merchantable	285	87.4	10,560	97.6	13,361	92.9	22.0	20.2	111.24	92.55
Submerchantable	20	6.1	255	2.4	303	2.1	0	12.9	51.64	45.74
Cull	21	6.5	-	-	713	5.0	[2/][3/]80.0	-	[4/]-	91.42
Total	326	100.0	10,815	100.0	14,377	100.0	[3/]28.3	26.3	[4/]115.55	91.49
Basswood										
Merchantable	52	74.3	1,540	88.0	1,823	84.3	9.4	12.5	97.75	86.89
Submerchantable	15	21.4	210	12.0	296	13.7	13.8	33.9	92.50	69.08
Cull	3	4.3	-	-	44	2.0	[2/][3/]80.0	-	[4/]-	52.14
Total	70	100.0	1,750	100.0	2,163	100.0	[3/]14.1	17.4	[4/]98.34	83.77
Paper birch										
Merchantable	18	75.0	420	91.3	488	88.4	8.7	10.4	84.92	76.92
Submerchantable	6	25.0	40	8.7	64	11.6	0	52.0	62.68	41.24
Total	24	100.0	460	100.0	552	100.0	[3/]9.8	14.0	82.96	72.83
Red maple										
Merchantable	21	95.5	540	96.4	857	98.3	32.3	50.8	85.94	56.99
Submerchantable	1	4.5	20	3.6	15	1.7	0	-28.8	27.77	39.00
Total	22	100.0	560	100.0	872	100.0	[3/]27.3	47.9	83.77	56.64

Table 1.--Amount and value of lumber produced from logs of different species and classes
(Continued)

Species and log class	Logs		Net log scale Scribner Decimal C		Green lumber tally		Cull	Overrun dry lumber 1/	Value per M bd. ft.	
									Log scale	Lumber tally
	Number	Percent	Bd.ft.	Percent	Bd.ft.	Percent	Percent	Percent	Dollars	
Black cherry										
Merchantable	17	94.4	450	95.7	476	95.0	10.0	0.5	57.67	57.38
Submerchantable	1	5.6	20	4.3	25	5.0	0 3/	18.8	47.38	39.88
Total	18	100.0	470	100.0	501	100.0	3/ 9.6	1.3	57.21	56.48
Ironwood										
Merchantable	12	70.6	210	70.0	262	72.8	14.3	18.5	56.99	48.09
Submerchantable	5	29.4	90	30.0	98	27.2	0 3/	3.4	56.71	54.82
Total	17	100.0	300	100.0	360	100.0	3/ 26.9	14.0	56.93	49.94
White ash										
Merchantable	5	100.0	320	100.0	307	100.0	11.1	-8.9	80.75	88.64
Total	5	100.0	320	100.0	307	100.0	11.1	-8.9	80.75	88.64
Elm										
Merchantable	5	100.0	150	100.0	196	100.0	16.7	24.1	61.73	49.74
Total	5	100.0	150	100.0	196	100.0	16.7	24.1	61.73	49.74
Total cut										
Merchantable	991	88.5	35,610	97.0	46,036	93.8	19.5	22.8	94.75	77.16
Submerchantable	81	7.2	1,110	3.0	1,652	3.4	4.2	41.4	71.82	50.79
Cull	48	4.3	-	-	1,390	2.8	-	-	-	78.18
Total	1,120	100.0	36,720	100.0	49,078	100.0	3/ 24.3	27.0	4/ 96.91	76.31

1/ The green lumber tally was reduced 5 percent before calculating the overrun.
2/ Cull percent of cull logs sawn is estimated to be 80 percent.
3/ Includes cull logs not sawn.
4/ The value per M log scale for the total is higher than for the merchantable logs only because the cull logs, which have no net scale, yielded some lumber which became part of the overrun.

The value per thousand of the lumber cut from the cull 1/ logs was very close to the value of the lumber cut from the merchantable logs. The cull sugar maple logs yielded lumber worth $5.43 per thousand board feet less than the value of the lumber from merchantable logs. The cull yellow birch logs yielded lumber worth only $1.13 per thousand less than the value of lumber from merchantable logs. The cull basswood logs yielded lumber worth $34.75 less per thousand than the merchantable logs. However, only three cull basswood logs were cut, so the data on this species are inconclusive. Cull logs contain a large amount of waste material and are more expensive to log and mill. However, since cull logs are given no net scale, there is no stumpage expense to charge against the cost of production of the lumber. In the case of yellow birch, this would result in a saving of about $25.00 per thousand board feet lumber tally. This saving should, to a large degree, compensate for the additional milling and logging cost.

Lumber Grades

The merchantable logs of all species except black cherry, elm, and ironwood yielded 20 percent or more No. 1 common and better lumber (table 2). White ash gave the highest grade yield with 64 percent of the lumber being No. 1 common or better. Basswood, which gave 37 percent of the higher grades, was the second best species. Yellow birch and paper birch yielded about the same percentage of the better grades with 34 percent and 33 percent No. 1 common and better, respectively. Sugar maple and red maple also gave about the same yield of the upper grades with the former yielding 22 percent No. 1 common and better while the latter yielded 20 percent of the same grades.

Lumber of very poor grade was obtained from the submerchantable logs of all species. Only basswood and ironwood gave more than 10 percent of the first three grades. The five small ironwood logs sawed yielded a higher percent of No. 1 common and better than the merchantable sized logs of the same species. All other species gave less than 5 percent of the first three grades.

Both sugar maple and yellow birch cull logs yielded about the same percent of higher grades as did the merchantable logs of the same species. Center rot in logs of these two species tends to remove the low-grade portion of the log and leave the part from which the high-grade lumber is produced. The three cull basswood logs cut gave very poor yields.

Overrun

Overrun, the percentage by which the dry lumber tally exceeds the log scale, varied by species but showed a common trend to decrease as log diameters or tree diameters increased.

For small logs, sugar maple had much higher overrun than other species (table 3). Sugar maple and yellow birch logs above 11 inches in top diameter (inside bark) were similar in overrun. The same general trend holds for trees of different sizes, although in that case the similarity in overrun between sugar maple and yellow birch holds above 16 inches d.b.h. (table 4).

1/ Less than one-third sound.

Table 2.--Lumber grade recovery by log classes

Species and log class	Logs	Lumber grades							
		FAS	Select	No. 1 common	No. 2 common	No. 3A common	No. 3B common	No. 3 common	Timbers
	Number	Percent of total lumber tally							
Sugar maple									
Merchantable	576	4.3	6.2	11.1	15.0	11.0	20.0	-	32.4
Submerchantable	33	0	0.5	1.9	6.0	7.1	42.2	-	42.3
Cull	24	2.8	4.9	12.8	10.8	17.2	40.8	-	10.7
Total	633	4.1	6.0	10.8	14.7	11.0	21.1	-	32.3
Yellow birch									
Merchantable	285	7.9	8.2	17.6	21.5	11.1	33.7	-	-
Submerchantable	20	0	0	1.0	11.2	11.6	76.2	-	-
Cull	21	5.2	9.2	20.5	22.9	6.9	35.3	-	-
Total	326	7.6	8.1	17.4	21.3	10.9	34.7	-	-
Basswood									
Merchantable	52	10.2	8.7	18.4	37.8	-	-	24.9	
Submerchantable	15	0	1.4	11.1	62.2	-	-	25.3	
Cull	3	0	0	6.8	22.7	-	-	70.5	
Total	70	8.6	7.5	17.2	40.9	-	-	25.8	
Paper birch									
Merchantable	18	3.1	10.2	19.3	19.7	-	-	47.7	
Submerchantable	6	0	0	4.7	1.6	-	-	93.7	
Total	24	2.7	9.1	17.6	17.6	-	-	53.0	
Red maple									
Merchantable	21	4.0	2.3	13.7	17.6	-	-	62.4	
Submerchantable	1	0	0	0	0	-	-	100.0	
Total	22	3.9	2.3	13.4	17.3	-	-	63.1	
Black cherry									
Merchantable	17	0	1.7	8.0	33.2	-	-	57.1	-
Submerchantable	1	0	0	0	8.0	-	-	92.0	-
Total	18	0	1.6	7.6	31.9	-	-	58.9	-
Ironwood									
Merchantable	12	0	2.7	9.9	20.6	-	-	66.8	-
Submerchantable	5	0	0	23.5	31.6	-	-	44.9	-
Total	17	0	2.0	13.6	23.6	-	-	60.8	-
White ash									
Merchantable	5	24.5	9.1	30.6	14.0	-	-	21.8	-
Elm									
Merchantable	5	0	0	7.1	39.8	-	-	53.1	-

Table 3.--Overrun[1] - percent of dry lumber tally over Scribner Decimal C log scale for second-growth hardwood logs [2]

Log top diameter (i.b.)	Overrun by species			
	Sugar maple	Yellow birch	Basswood	Miscellaneous [3]
Inches	Percent	Percent	Percent	Percent
8	48.4	27.3	23.5	20.3
9	39.9	26.1	20.1	17.8
10	33.5	24.8	14.6	15.8
11	27.7	23.2	7.5	14.4
12	22.2	21.4	1.8	13.1
13	18.2	19.2	-0.6	12.2
14	14.2	16.3	-2.6	11.4
15	11.0	12.3		10.6
16	7.8	8.4		
17	5.0	4.3		
18	2.4	0.7		
19	-0.3	-2.2		
20	-2.1	-4.6		

1/ Overrun equals dry lumber tally, minus net log scale, divided by net log scale, expressed as a percentage.

2/ This table is based on curved data for merchantable logs only.

3/ Includes paper birch, ash, elm, ironwood, red maple, and black cherry.

Table 4.--Overrun - percent of dry lumber tally over Scribner Decimal C net log scale for second-growth hardwood trees 1/

Tree D.B.H. (o.b.)	Overrun by species			
	Sugar maple	Yellow birch	Basswood	Miscellaneous
Inches	Percent	Percent	Percent	Percent
9	52.2	27.9	24.5	22.0
10	47.7	27.3	24.2	20.2
11	43.1	26.6	23.2	18.7
12	38.8	25.9	21.1	17.4
13	34.9	25.0	18.5	16.2
14	31.2	24.1	15.0	15.2
15	27.7	23.1	10.5	14.4
16	24.5	21.8	6.6	13.6
17	21.5	20.4	3.4	12.8
18	18.7	18.7	0.9	12.2
19	15.9	16.7	-0.9	11.6
20	13.2	14.4		
21	10.7	11.7		
22	8.3	8.9		
23	6.2	6.1		
24	4.2	3.6		
25	2.4	1.4		
26	0.8	-0.7		

1/ This table is based on curved data derived from table 3 and average taper tables.

Because they were obtained from one mill and one timber stand, these overrun figures are of limited use. However, they provide an estimate of the overrun that will be obtained from second-growth improvement cuts sawn in a 1/4-inch circular mill in northeastern Wisconsin.

For small mills, overrun figures are at best rough estimates, even for future cuts of the mill at which they were made. This type of mill generally cuts for its own market, or the best market that can currently be found. If mostly 1-inch lumber is produced the overrun will be lower than if thicker lumber were cut. Well-manufactured lumber, cut for high grades, will yield less overrun than lumber cut with little regard to grade. These, as well as log size, log quality, species, and other factors, can affect the amount of overrun produced at any one mill.

Applicability of Forest Products Laboratory Log Grades to Second-growth Hardwoods

One of the major aims of this study was to determine whether the hardwood log grade rules and tables developed by the Forest Products Laboratory at Madison, Wisconsin, could successfully predict the lumber values obtained from second-growth hardwoods in northern Wisconsin. Because only two species, sugar maple and yellow birch, had sufficient volume in all three grades to form a basis for comparison, the ensuing discussion concerns them only.

Proportionately more high-quality yellow birch logs than sugar maple logs were produced (table 5). About 14 percent of the yellow birch lumber produced was from No. 1 logs, as compared to 6 percent for sugar maple. About the same proportion of the volume of both species was in log grade No. 2. Considerably more than half of the lumber volume of sugar maple came from logs of grade 3.

The log grade tables of thickness did not apply because the current orders at the mill where the study was conducted were for 4/4 sugar maple and 5/4 yellow birch. Consequently, in the upper grades these thicknesses were cut exclusively. The mill also had a market for hardwood timbers from the lower grades. Therefore, a high percentage of the No. 3A and 3B common grades was cut into timbers.

There was considerable error in the estimate when taken by individual grades (table 6). With the exception of grade No. 1 logs, the estimate was too low in the first two lumber grades and too high in the No. 1 common and No. 2 common lumber grades in sugar maple. The percentage of No. 3B common lumber and timbers was underestimated in all grades for sugar maple and overestimated in all grades for yellow birch. Higher lumber grades than predicted were cut from both No. 2 and No. 3 yellow birch logs.

These errors tended to balance when values of the lumber grades were taken into account. The estimate of the value per thousand board feet of lumber for the total cut of both sugar maple and yellow birch was within 10 percent of the actual value (table 7). This is sufficiently close, so that the Forest Products Laboratory log grading system can be said to apply satisfactorily to second-growth hardwood in northern Wisconsin.

Table 5.--Distribution of volume within the three Forest Products Laboratory log grades

Log grade	Sugar maple		Yellow birch	
	Volume, green lumber tally		Volume, green lumber tally	
Number	Bd.ft.	Percent	Bd.ft.	Percent
1	1,695	6.0	1,851	13.8
2	10,069	35.6	5,311	39.8
3	16,502	58.4	6,199	46.4
Total	28,266	100.0	13,361	100.0

Table 6.--Forest Products Laboratory estimates versus actual yield

Log grade	Estimate or actual	Lumber volume in: FAS	Select	No. 1 common	No. 2 common	No. 3A common	No. 3B & timbers	Lumber tally value per M 1/
				Percent of total				Dollars
SUGAR MAPLE								
1	Estimate	21.0	14.0	30.9	12.0	4.8	17.3	116.61
	Actual	18.9	13.3	17.8	18.2	6.6	25.2	105.38
2	Estimate	4.1	5.7	28.0	19.8	8.4	34.0	83.20
	Actual	7.0	10.5	15.2	17.1	10.3	39.9	83.55
3	Estimate	0.3	1.1	14.2	20.7	14.6	49.1	62.75
	Actual	1.1	2.8	7.8	13.5	11.9	62.9	59.04
Total cut	Estimate	2.9	3.5	20.1	19.8	11.8	41.9	73.26
	Actual	4.3	6.2	11.1	15.0	11.0	52.4	70.55
YELLOW BIRCH								
1	Estimate	27.3	7.9	30.1	12.2	3.7	18.8	133.86
	Actual	16.3	10.7	27.2	21.9	10.8	13.1	120.96
2	Estimate	6.4	4.9	26.8	20.0	7.4	34.5	92.56
	Actual	12.1	12.0	20.4	20.1	7.7	27.7	107.65
3	Estimate	0.5	1.2	12.4	19.8	7.8	58.3	62.25
	Actual	1.7	4.3	12.4	22.4	14.1	45.1	71.16
Total cut	Estimate	6.6	3.6	20.5	18.8	7.1	43.4	84.22
	Actual	7.9	8.2	17.6	21.5	11.1	33.7	92.55

1/ Lumber value based on list price of November 25, 1949.

Table 7.--Error of estimated value in percent of actual value of sugar maple and yellow birch logs by Forest Products Laboratory log grades

Log grade	Error of estimate by species	
	Sugar maple	Yellow birch
	Percent	Percent
1	+ 10.7	+ 10.7
2	- 0.4	- 14.0
3	+ 6.3	- 12.5
Total cut	+ 3.8	- 9.0

Cost and Returns

Records of logging and milling costs were kept for the entire operation, and selling prices were determined from current lumber prices at the time of milling (table 8). The cost of logging and milling the cull and submerchantable logs was not kept separate from the costs on merchantable logs. However, the differences between costs and returns were sufficient so that the operation as a whole was profitable.

Summary

1. Timber from improvement cuts in second-growth northern hardwoods in northern Wisconsin can yield lumber of a value that makes commercial operations practicable under present merchantability standards.

2. Sugar maple and yellow birch cull logs (those less than one-third sound) of comparable size and form yield lumber about equal in value to to that obtained from merchantable logs.

3. Submerchantable (below minimum top diameter) hardwood logs yield very low quality lumber. These logs cannot be cut profitably for factory lumber.

4. The log grade rules and recovery tables developed by the Forest Products Laboratory at Madison, Wisconsin, primarily for old-growth hardwoods, apply satisfactorily to second-growth hardwoods in northeastern Wisconsin.

Table 8.--Cost and returns for total cut by species (includes cull and submerchantable logs)

Species	Logging cost per M bd.ft. dry lumber tally	Milling cost per M bd.ft. dry lumber tally	Total[1] cost per M bd.ft. dry lumber tally f.o.b. trucks	Selling price per M bd.ft. dry lumber tally	Margin for profit, risk, and stumpage per M bd.ft. dry lumber tally	Indicated[2] stumpage value with a profit ratio of .10	
						Per M bd.ft. dry lumber tally	Per M bd.ft. net log scale Scrib. Dec. C
	Dollars						
Sugar maple	25.23	24.43	53.15	69.77	16.62	10.28	13.27
Yellow birch	25.80	24.43	54.80	91.49	36.69	28.37	35.83
All hardwood species weighted	25.65	24.43	53.90	76.31	22.41	15.47	19.65

1/ Includes 5 percent of selling price as selling expense.

2/ Profit ratio is the selling price minus both the manufacturing cost and stumpage divided by the manufacturing cost plus stumpage.

COMMON AND SCIENTIFIC NAMES OF SPECIES

MENTIONED IN THE TEXT

Common Name	Scientific Name
Ash, white	Fraxinus americana L.
Basswood	Tilia americana L.
Birch, paper	Betula papyrifera Marsh.
Birch, yellow	B. lutea Michx. f.
Cherry, black	Prunus serotina Ehrh.
Elm (American)	Ulmus americana L.
Ironwood (Eastern hophornbeam)	Ostrya virginiana (Mill.) K. Koch
Maple, red	Acer rubrum L.
Maple, sugar	A. saccharum Marsh

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Number	
*1	Revised forest statistics for the Lake States, 1945, by the Forest Survey Staff, R. N. Cunningham, Regional Director. Sept. 1946.
*2	Postwar problems of the cross tie industry in the Lake States, by Arthur G. Horn and Harold F. Scholz. Sept. 1946.
3	Estimating cull in northern hardwoods, by W. M. Zillgitt and S. R. Gevorkiantz. Nov. 1946.
4	The reforestation job in the Lake States - a new estimate, by Paul O. Rudolf. Nov. 1946.
5	Lake States forests and the pulp and paper industry, by E. L. Demmon. Dec. 1946.
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15	Publications of the Lake States Forest Experiment Station, 1923-1948, by the Lake States Forest Experiment Station. Jan. 1949. Supplement No. 1. Dec. 1951.
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* Not available for distribution.